FORM PTO-1390 (REV. 11-2000) — U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U S. APPLICATION NO (If known, see 37 CFR 1 5)
LEN-021022	10/069830

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/08191	8/22/2000	8/26/1999

TITLE OF INVENTION SHAFT MOUNTING

APPLICANT(S) FOR DO/EO/US Peter Hessling

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371 (f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [X] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3))
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371©)(4)). (unsigned)
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [X] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [X] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information: "Original English translation of Specification with markings to show change;" Abstract; Copy of the International Search Report; Return Postcard and Certificate of Mailing by Express Mail

U.S. APPLICATION NO (if known, see 37 CFR 1 5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/069830	PCT/EP00/08191	LEN-021022

21. [X] The following fees are submitted:

	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,040.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $740.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00	

ENTER APPROPRIATE BASIC FEE AMOUNT =				$890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [X] 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				$130.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	11 - 20 =	0	x **$18.00**	$0.00	
Independent claims	1 - 3 =	0	x **$84.00**	$0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**		
TOTAL OF ABOVE CALCULATIONS =				$1,020.00	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$1,020.00	
SUBTOTAL =				$1,020.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [X] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$130.00	
TOTAL NATIONAL FEE =				$1,150.00	
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$0.00	
TOTAL FEES ENCLOSED =				$1,150.00	
				Amount to be refunded:	$
				charged:	$

a. [X] A check in the amount of $ 1,150.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-0545. A duplicate copy of this sheet is enclosed.

d. [ ] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Jody L. Factor
FACTOR & PARTNERS, LLC
1327 W. Washington Blvd., Suite 5G/H
Chicago, IL 60607
(312) 226-1818
(312) 226-1919 (fax)

SIGNATURE

Jody L. Factor
NAME

34157
REGISTRATION NUMBER

IN THE
UNITED STATES
PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	Hessling
CASE:	LEN-021022
SERIAL NO.:	Not yet assigned
FILED ON:	February 26, 2002
FOR:	SHAFT MOUNTING

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER
FOR PATENTS
Washington DC 20231

ATTENTION OF:

EXAMINER:

Dear Sir:

If any charges or fees must be paid in connection with the following communication, they may be paid out of our Deposit Account No. 50-0545.

Please enter the foregoing preliminary amendment **PRIOR** to calculation of filing fees and substantive examination of the claims.

FACTOR & PARTNERS, LLC
1327 W. Washington Blvd., Suite 5G/H
Chicago, IL 60607
(312) 226-1818
(312) 226-1919

Jody L. Factor

34157

IN THE CLAIMS CANCEL

Please cancel claims 1-11, without prejudice.

IN THE CLAIMS ADD

Please add claims 12-22 as follows:

12. A pneumatic actuator comprising:
- a housing wherein the housing includes:
  - a pneumatic cylinder having an axis;
  - at least one piston that can move inside the cylinder in the direction of the axis of the cylinder, wherein the piston, together with the cylinder delimits a working space;
  - the at least one piston including teeth which extend in the direction of the axis of the cylinder;
  - a shaft which can rotate in an axial direction whose axial direction is perpendicular to the axis of the cylinder;
  - the shaft having teeth that engage with the teeth of the at least one piston, characterized in that the piston fixes the shaft in its axial direction by means of positive engagement.

13. The pneumatic actuator according to claim 12, characterized in that the shaft has at least one peripheral groove that engages with a segment of the at least one piston running in the axial direction.

14. The pneumatic actuator according to claim 12, characterized in that the shaft has two bearing sites that form the areas where the shaft has its greatest diameter.

15. The pneumatic actuator according to claim 12, characterized in that the shaft is mounted directly in the housing at two bearing sites.

16. The pneumatic actuator according to claim 14, characterized in that the bearing sites of the shaft essentially have the same diameter.

17. The pneumatic actuator according to claim 13, characterized in that the groove is a peripherally cut groove.

18. The pneumatic actuator according to claim 12, characterized in that each of the at least one piston has a total of two segments, wherein the segments are positioned adjacent the piston teeth.

19. The pneumatic actuator according to claim 12, characterized in that the at least one piston is made of plastic.

20. The invention according to claim 14, wherein the pneumatic actuator includes a working area in the area of the bearing sites of the shaft;

- the working area being sealed from the exterior by means of sealing rings that are placed in a groove of the shaft

21. A method to mount an actuator according to claim 14, characterized in that the shaft is inserted in the bearing sites, and then the at least one piston is engaged with the shaft.

22. The method according to claim 21, characterized in that the shaft is held in the bearing sites without additional fasteners.

IN THE SPECIFICATION

Pursuant to 37 C.F.R. 1.125, please delete the present specification (all parts other than the claims) and replace it with the attached "Clean copy of Substitute Specification and of Abstract." The "Substitute" Specification contains no new matter. Pursuant to the rules, Applicant has likewise attached an "Original English translation of the Specification with markings to show changes" (as a marked up version of the Substitute Specification).

REMARKS

Applicant respectfully submits that no new matter was added to the new claims or Substitute Specification. Such changes were added solely for conformance with U.S. practice (i.e. removal of multiple dependencies, clarifications due to translation issues, adding an "Abstract" and identifying the application by proper headings). All such changes have been made prior to substantive U.S. Examination and not in view of any prior art.

Upon entry of the foregoing, the application is in condition for substantive examination at the present time.

Should anything further be required, a telephone call to the undersigned, at (312) 226-1818, is respectfully invited.

Respectfully submitted,

FACTOR & PARTNERS, LLC

Dated: February 26, 2002

Jody L. Factor
One of Attorneys for Applicant

SUMMARY OF THE INVENTION

[00004] Since the invention provides that the piston fixes the shaft in its axial direction by means of a keyed fit, the shaft can move axially until the piston is inserted and hence be moved into its position without additional fasteners. As soon as the piston is inserted, the positive engagement fixes the shaft axially which is brought about in the state of the art by means of an end bracket and snap rings.

[00005] A particularly simple embodiment results when the shaft has at least one peripheral groove that engages with a segment of the piston running in an axial direction. When the shaft also has two bearing sites that form the areas where the shaft has the largest diameter, the shaft can be easily guided from the outside into the housing and fits in the area of the bearing sites. Separate bearings are essentially dispensable when the shaft is mounted directly in the housing at two bearing sites. The shaft is mounted with minimal force when the bearing sites of the shaft essentially have the same diameter and thereby eliminate pressure in both directions. This also increases the length of time the shaft remains fixed at the segments and grooves.

[00006] It is particularly easy to create the groove when manufacturing the shaft when the groove is a peripherally cut groove. A symmetrical arrangement that allows the use of two identical piston results when each piston has two segments neighboring the teeth. In addition, the working area at the bearing sites of the shaft can also be sealed from the exterior by means of sealing rings made of rubber or plastic lying in a shaft groove.

[00007] A particularly advantageous method to mount the described actuator results when the shaft is first inserted into the bearing sites and then the piston(s) is engaged with the shaft so that the shaft is fixed in an axial direction without additional fasteners and, in particular, is held in the bearing sites.

BREIF DESCRIPTION OF THE DRAWINGS

[00008] An exemplary embodiment of the present invention will be described with reference to the following drawings, wherein:

[00009] Fig. 1 is a cross-section of an actuator according to the present invention following the axial direction of the shaft viewed in direction of the lengthwise axis of the cylinder; and

[00010] Fig. 2 is a cross-section of an actuator following the lengthwise axis of the cylinder. The perspective coincides with the axial direction of the shaft.

DETAILED DESCRIPTION OF THE DRAWING

[00011] Fig. 1 illustrates a pneumatic actuator according to the invention with a housing 1, a shaft 3 mounted in the housing that rotates around an axis of 2, and two pneumatic pistons 4 and 5. The inside of the housing 1 forms a cylindrical hole 6 in which the pistons 4 and 5 are inserted to form a sealed working area. The lengthwise axis of the hole 6 is perpendicular to the plane of projection.

[00012] The shaft 3 is essentially rotational symmetrical and has the following sections from bottom to top in Fig. 1:

[00013] The bottom end of the shaft forms a bearing area 10 that also represents the site where the shaft 3 has greatest diameter. Abutting bearing area 10 is a cut groove 11 with a boxlike cross-section. Adjacent to the groove 11 are teeth 12 like a pinion with teeth flanks parallel to the axis 2. The top end of the teeth 12 in turn abut a peripherally cut groove 13 that neighbors a bearing area 14. The bearing area 14 of the shaft 3 is also flush with the outside of the housing 1 like bearing area 10. On the top end of the shaft 3 in Fig. 1 is a conventional dihedron 15.

[00014] The pistons 4 and 5 as represented in Fig. 1 are cut where they engage with the shaft 3. At this area, the pistons 4 and 5 have outwardly projecting teeth 20 like a pinion that mesh with the teeth 12 of the shaft 3. The axial edges of the teeth 20 each abut a segment 21 that is formed as a single piece with the pistons 4 and 5, and that engages in the grooves 11 and 13. The housing 1 has a through hole that runs in the direction of the axis 2 and that vertically intersects the middle of the midaxis of the cylinder 6. This hole forms bearing sites 22 that, together with bearing sites 10 and 14 of the shaft 3, form a friction bearing to rotate the shaft around the axis 2. In the area of the bearing sites 22, the interior of the cylinder 6 is sealed from the atmosphere with sealants (not shown) such as O-rings.

[00015] Fig. 2 shows the actuator from Fig. 1 in a cross-section along the axis of the cylinder 6. The axis 2 of the shaft 3 is perpendicular to the plane of projection in the drawing in Fig. 2. The same components have the same reference numbers.

[00016] Fig. 2 illustrates how the pistons 4 and 5 symmetrically surround the shaft 3. The pistons 4 and 5 bear sealing piston heads 30 that interact with the cylinder 6 and that abut the pinion-like area with the teeth 20. Plate-like cylinder heads 31 seal the housing 1 at the faces of

the cylindrical hole 6. The pistons 4, 5, the cylindrical hole 6 and the cylinder heads 31 thereby delimit a total of three working areas 32, 33 and 34 of which working areas 32 and 34 have a pneumatic parallel connection, and working area 33 can independently receive pressure. Corresponding connection holes for working areas 32, 33 and 34 are identified with reference numbers 35, 36 and 37.

[00017] In practice, the actuator under consideration is mounted by first inserting the shaft 3 along the direction of the axis 2 into the housing 1, or more precisely, into the through hole with the bearing sites 22 until the position in Fig. 1 is reached. Then proceeding from the open ends of the cylindrical hole 6, a piston is inserted on each side of the shaft 3 so that the teeth 20 engage with the teeth 12. At the same time, the segments 21 that run parallel to the teeth 12 engage in the grooves 11, 13. The pistons 4, 5 are then pressed symmetrically into the hole 6. This rotates the shaft 3 on its axis 2, the teeth 12 and 20 engage with each other, and the segments 21 slide in the grooves 11, 13. The positive engagement of segments 21 in the grooves 11, 13 fixes the shaft in the direction of the axis 2 without additional fasteners being required. The cylinder 6 is sealed with the cylinder heads 31 and provided with the required pneumatic connections.

[00018] When the actuator is used, working area 33 (for example) is supplied with pressure so that the pistons 4 and 5 are pushed apart. In the drawing in Fig. 2, this causes the shaft 3 to rotate counterclockwise while the working areas 32 and 34 are vented. As would be understood by those having ordinary skill in the art, for the shaft 3 to rotate clockwise, the working areas 32 and 34 are supplied with pressure while working areas 33 is vented.

[00019] It is preferable for the grooves as portrayed in this exemplary embodiment to abut the side of the teeth 12, and for the pistons 4 and 5 to each have two segments 21. The outer edge of the segments 21 slides to contact the outer walls of the grooves 11, 13 during operation, while the segments 21 are at a slight distance from the teeth 12. The shaft 3 is only guided axially during operation by the flanks of the pistons.

[00020] In the present case, the preferred materials for an actuator according to the invention are aluminum for the housing 1 and the shaft 3, and plastic for the pistons 4 and 5. The seal at the bearing sites can be attained by self lubricating plastics. Other materials or combinations of materials are equally conceivable, however. The bearing only receives a small amount of stress during operation since it is an actuator as used for actuating valves.

[00021] The foregoing description merely explains and illustrates the invention and the invention is not limited thereto except insofar as the appended claims are so limited, as those skilled in the art who have the disclosure before them will be able to make modifications without departing from the scope of the invention.

ABSTRACT

[00022] A pneumatic actuator having a pneumatic cylinder. At least one piston is movably positioned within the cylinder. The piston includes teeth which extend in the longitudinal direction of the cylinder. The teeth engage with teeth of a rotatable shaft which rotates perpendicular to the axis of the cylinder.

TITILE OF THE INVENTION

SHAFT MOUNTING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention [concerns] is directed to a pneumatic actuator [with the features of the preamble of claim 1].

2. Background Art

[Such an actuator is] Pneumatic actuators are known in the prior art [from] such as, for example German utility model G9014487.2. In prior-art actuators, the drive shaft is mounted in the housing with two end brackets. The end brackets are inserted into the housing from the inside that forms the cylinder, and the shaft is also fixed in an axial direction from the inside with exterior lock washers or snap rings. Installing the bearing and the lock washers from the work area of the cylinder is a rather difficult manual job which gives rise to undesirable costs.

It is therefore [the problem] an object of the present invention to improve a pneumatic actuator so that the shaft and pistons can be more easily installed in the housing with fewer required parts.

[This problem is solved with an actuator that has the features of claim 1.]

SUMMARY OF THE INVENTION

Since the invention provides that the piston fixes the shaft in its axial direction by means of a keyed fit, the shaft can move axially until the piston is inserted and hence be moved into its position without additional fasteners. As soon as the piston is inserted, the positive engagement fixes the shaft axially which is brought about in the state of the art by means of [the] an end bracket and snap rings.

A particularly simple embodiment results when the shaft has at least one peripheral groove that engages with a segment of the piston running in an axial direction. When the shaft also has two bearing [areas] sites that form the areas where the shaft has the largest diameter, the shaft can be easily guided from the outside into the housing and fits [and] in the area of the bearing sites. Separate bearings are essentially dispensable when the shaft is mounted directly in the housing at two bearing sites. The shaft is mounted with minimal force when the bearing sites of the shaft essentially have the same diameter and thereby eliminate pressure in both directions. This also increases the length of time the shaft remains fixed at the segments and grooves.

It is particularly easy to create the groove when manufacturing the shaft when the groove is a peripherally cut groove. A symmetrical arrangement that allows the use of two identical piston results when each piston has two segments neighboring the teeth. In addition, the working area at the bearing sites of the shaft can also be sealed from the exterior by means of sealing rings made of rubber or plastic lying in a shaft groove.

A particularly advantageous method to mount the described actuator results when the shaft is first inserted into the bearing sites and then the piston(s) is engage[s]ed with the shaft so that the shaft is fixed in an axial direction without additional fasteners and, in particular, is held in the bearing sites.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the present invention will be described [in the following] with reference to the following drawings[.] , wherein

[Shown are:]

Fig. 1[: A] is a cross-section of an actuator according to the present invention following the axial direction of the shaft viewed in direction of the lengthwise axis of the cylinder; and

Fig. 2[: A] is a cross-section of an actuator following the lengthwise axis of the cylinder. The perspective coincides with the axial direction of the shaft.

DETAILED DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a pneumatic actuator according to the invention with a housing 1, a shaft 3 mounted in the housing that rotates around an axis of 2, and two pneumatic pistons 4 and 5. The inside of the housing 1 forms a cylindrical hole 6 in which the pistons 4 and 5 are inserted to form a sealed working area. The lengthwise axis of the hole 6 is perpendicular to the plane of projection.

The shaft 3 is essentially rotational symmetrical and has the following sections from bottom to top in Fig. 1:

The bottom end of the shaft forms a bearing area 10 that also represents the site where the shaft 3 has greatest diameter. Abutting bearing area 10 is a cut groove 11 with a boxlike cross-section. Adjacent to the groove 11 are teeth 12 like a pinion with teeth flanks parallel to the axis 2. The top end of the teeth 12 in turn abut a peripherally cut groove 13 that neighbors a bearing area 14. The bearing area 14 of the shaft 3 is also flush with the outside of the housing 1 like bearing area 10. On the top end of the shaft 3 in Fig. 1 is a conventional dihedron 15.

The pistons 4 and 5 as represented in Fig. 1 are cut where they engage with the shaft 3. At this area, the pistons 4 and 5 have outwardly projecting teeth 20 like a pinion that mesh with the teeth 12 of the shaft 3. The axial edges of the teeth 20 each abut a segment 21 that is formed as a single piece with the pistons 4 and 5, and that engages in the grooves 11 and 13. The housing 1 has a through hole that runs in the direction of the axis 2 and that vertically intersects the middle of the midaxis of the cylinder 6. This hole forms bearing sites 22 that, together with bearing sites 10 and 14 of the shaft 3, form a friction bearing to rotate the shaft around the axis 2 . In the area of the bearing sites 22, the interior of the cylinder 6 is sealed from the atmosphere with sealants (not shown) such as O-rings.

Fig. 2 shows the actuator from Fig. 1 in a cross-section along the axis of the cylinder 6. The axis 2 of the shaft 3 is perpendicular to the plane of projection in the drawing in Fig. 2. The same components have the same reference numbers.

Fig. 2 illustrates how the pistons 4 and 5 symmetrically surround the shaft 3. The pistons 4 and 5 bear sealing piston heads 30 that interact with the cylinder 6 and that abut the pinion-like area with the teeth 20. Plate-like cylinder heads 31 seal the housing 1 at the faces of the cylindrical hole 6. The pistons 4, 5, the cylindrical hole 6 and the cylinder heads 31 thereby

delimit a total of three working areas 32, 33 and 34 of which working areas 32 and 34 have a pneumatic parallel connection, and working area 33 can independently receive pressure. Corresponding connection holes for working areas 32, 33 and 34 are identified with reference numbers 35, 36 and 37.

In practice, the actuator under consideration is mounted by first inserting the shaft 3 along the direction of the axis 2 into the housing 1, or more precisely, into the through hole with the bearing sites 22 until the position in Fig. 1 is reached. Then proceeding from the open ends of the cylindrical hole 6, a piston is inserted on each side of the shaft 3 so that the teeth 20 engage with the teeth 12. At the same time, the segments 21 that run parallel to the teeth 12 engage in the grooves 11, 13. The pistons 4, 5 are then pressed symmetrically into the hole 6. This rotates the shaft 3 on its axis 2, the teeth 12 and 20 engage with each other, and the segments 21 slide in the grooves 11, 13. The positive engagement of segments 21 in the grooves 11, 13 fixes the shaft in the direction of the axis 2 without additional fasteners being required. The cylinder 6 is sealed with the cylinder heads 31 and provided with the required pneumatic connections.

When the actuator is used, working area 33 (for example) is supplied with pressure so that the pistons 4 and 5 are pushed apart. In the drawing in Fig. 2, this causes the shaft 3 to rotate counterclockwise while the working areas 32 and 34 are vented. [For] As would be understood by these having ordinary skill in the art, the shaft 3 to rotate clockwise, the working areas 32 and 34 are supplied with pressure while working areas 33 is vented. [This method is known from the state-of-the-art.]

It is preferable for the grooves as portrayed in this exemplary embodiment to abut the side of the teeth 12, and for the pistons 4 and 5 to each have two segments 21. The outer edge of the segments 21 slides to contact the outer walls of the grooves 11, 13 during operation, while the segments 21 are at a slight distance from the teeth 12. The shaft 3 is only guided axially during operation by the flanks of the pistons.

In the present case, the preferred materials for an actuator according to the invention are aluminum for the housing 1 and the shaft 3, and plastic for the pistons 4 and 5. The seal at the bearing sites can be attained by self lubricating plastics. Other materials or combinations of materials are equally conceivable, however. The bearing only receives a small amount of stress during operation since it is an actuator as used for actuating valves.

The foregoing description merely explains and illustrates the invention and the invention is not limited thereto except insofar as the appended claims are so limited, as those skilled in the art who have the disclosure before them will be able to make modifications without departing from the scope of the invention.

ABSTRACT

A pneumatic actuator having a pneumatic cylinder. At lease one piston is movable positioned within the cylinder. The piston includes teeth which extend in the longitudinal direction of the cylinder. The teeth engage with teeth of a rotatable shaft which rotates perpendicular to the axis of the cylinder.

TITLE OF THE INVENTION

SHAFT MOUNTING

BACKGROUND OF THE INVENTION

1. Field of the Invention

[00001] The present invention is directed to a pneumatic actuator.

2. Background Art

[00002] Pneumatic actuators are known in the prior art such as, for example, German utility model G9014487.2. In prior-art actuators, the drive shaft is mounted in the housing with two end brackets. The end brackets are inserted into the housing from the inside that forms the cylinder, and the shaft is also fixed in an axial direction from the inside with exterior lock washers or snap rings. Installing the bearing and the lock washers from the work area of the cylinder is a rather difficult manual job which gives rise to undesirable costs.

[00003] It is therefore an object of the present invention to improve a pneumatic actuator so that the shaft and pistons can be more easily installed in the housing with fewer required parts.

2/pr

Shaft Mounting

The present invention concerns a pneumatic actuator with the features of the preamble of claim 1.

Such an actuator is prior art from German utility model G9014487.2. In prior-art actuators, the drive shaft is mounted in the housing with two end brackets. The end brackets are inserted into the housing from the inside that forms the cylinder, and the shaft is also fixed in an axial direction from the inside with exterior lock washers or snap rings. Installing the bearing and the lock washers from the work area of the cylinder is a rather difficult manual job which gives rise to undesirable costs.

It is therefore the problem of the present invention to improve a pneumatic actuator so that the shaft and pistons can be more easily installed in the housing with fewer required parts.

This problem is solved with an actuator that has the features of claim 1.

Since the invention provides that the piston fixes the shaft in its axial direction by means of a keyed fit, the shaft can move axially until the piston is inserted and hence be moved into its position without additional fasteners. As soon as the piston is inserted, the positive engagement fixes the shaft axially which is brought about in the state of the art by means of the end bracket and snap rings.

A particularly simple embodiment results when the shaft has at least one peripheral groove that engages with a segment of the piston running in an axial direction. When the shaft also has two bearing areas that form the areas where the shaft has the largest diameter, the shaft can be easily guided from the outside into the housing and fits and the area of the bearing sites. Separate bearings are essentially dispensable when the shaft is mounted directly in the housing at two bearing sites. The shaft is mounted with minimal force when the bearing sites of the shaft essentially have the same diameter and thereby

eliminate pressure in both directions. This also increases the length of time the shaft remains fixed at the segments and grooves.

It is particularly easy to create the groove when manufacturing the shaft when the groove is a peripherally cut groove. A symmetrical arrangement that allows the use of two identical piston results when each piston has two segments neighboring the teeth. In addition, the working area at the bearing sites of the shaft can also be sealed from the exterior by means of sealing rings made of rubber or plastic lying in a shaft groove.

A particularly advantageous method to mount the described actuator results when the shaft is first inserted into the bearing sites and then the piston(s) is engages with the shaft so that the shaft is fixed in an axial direction without additional fasteners and, in particular, is held in the bearing sites.

An exemplary embodiment of the present invention will be described in the following with reference to drawings.

Shown are:

Fig. 1: A cross-section of an actuator according to the invention following the axial direction of the shaft viewed in direction of the lengthwise axis of the cylinder; and

Fig. 2: A cross-section of an actuator following the lengthwise axis of the cylinder. The perspective coincides with the axial direction of the shaft.

Fig. 1 illustrates a pneumatic actuator according to the invention with a housing 1, a shaft 3 mounted in the housing that rotates around an axis of 2, and two pneumatic pistons 4 and 5. The inside of the housing 1 forms a cylindrical hole 6 in which the pistons 4 and 5 are inserted to form a sealed working area. The lengthwise axis of the hole 6 is perpendicular to plane of projection.

The shaft 3 is essentially rotational symmetrical and has the following sections from bottom to top in Fig. 1:

The bottom end of the shaft forms a bearing area 10 that also represents the site where the shaft 3 has greatest diameter. Abutting bearing area 10 is a cut groove 11 with a boxlike cross-section. Adjacent to the groove 11 are teeth 12 like a pinion with teeth flanks parallel to the axis 2. The top end of the teeth 12 in turn abut a peripherally cut groove 13 that neighbors a bearing area 14. The bearing area 14 of the shaft 3 is also flush with the outside of the housing 1 like bearing area 10. On the top end of the shaft 3 in Fig. 1 is a conventional dihedron 15.

The pistons 4 and 5 as represented in Fig. 1 are cut where they engage with the shaft 3. At this area, the pistons 4 and 5 have outwardly projecting teeth 20 like a pinion that mesh with the teeth 12 of the shaft 3. The axial edges of the teeth 20 each abut a segment 21 that is formed as a single piece with the pistons 4 and 5, and that engages in the grooves 11 and 13. The housing 1 has a through hole that runs in the direction of the axis 2 and that vertically intersects the middle of the midaxis of the cylinder 6. This hole forms bearing sites 22 that, together with bearing sites 10 and 14 of the shaft 3, form a friction bearing to rotate the shaft around the axis 2 . In the area of the bearing sites 22, the interior of the cylinder 6 is sealed from the atmosphere with sealants (not shown) such as O-rings.

Fig. 2 shows the actuator from Fig. 1 in a cross-section along the axis of the cylinder 6. The axis 2 of the shaft 3 is perpendicular to the plane of projection in the drawing in Fig. 2. The same components have the same reference numbers.

Fig. 2 illustrates how the pistons 4 and 5 symmetrically surround the shaft 3. The pistons 4 and 5 bear sealing piston heads 30 that interact with the cylinder 6 and that abut the pinion-like area with the teeth 20. Plate-like cylinder heads 31 seal the housing 1 at the faces of the cylindrical hole 6. The pistons 4, 5, the cylindrical hole 6 and the cylinder

heads 31 thereby delimit a total of three working areas 32, 33 and 34 of which working areas 32 and 34 have a pneumatic parallel connection, and working area 33 can independently receive pressure. Corresponding connection holes for working areas 32, 33 and 34 are identified with reference numbers 35, 36 and 37.

In practice, the actuator under consideration is mounted by first inserting the shaft 3 along the direction of the axis 2 into the housing 1, or more precisely, into the through hole with the bearing sites 22 until the position in Fig. 1 is reached. Then proceeding from the open ends of the cylindrical hole 6, a piston is inserted on each side of the shaft 3 so that the teeth 20 engage with the teeth 12. At the same time, the segments 21 that run parallel to the teeth 12 engage in the grooves 11, 13. The pistons 4, 5 are then pressed symmetrically into the hole 6. This rotates the shaft 3 on its axis 2, the teeth 12 and 20 engage with each other, and the segments 21 slide in the grooves 11, 13. The positive engagement of segments 21 in the grooves 11, 13 fixes the shaft in the direction of the axis 2 without additional fasteners being required. The cylinder 6 is sealed with the cylinder heads 31 and provided with the required pneumatic connections.

When the actuator is used, working area 33 (for example) is supplied with pressure so that the pistons 4 and 5 are pushed apart. In the drawing in Fig. 2, this causes the shaft 3 to rotate counterclockwise while the working areas 32 and 34 are vented. For the shaft 3 to rotate clockwise, the working areas 32 and 34 are supplied with pressure while working areas 33 is vented. This method is known from the state-of-the-art.

It is preferable for the grooves as portrayed in this exemplary embodiment to abut the side of the teeth 12, and for the pistons 4 and 5 to each have two segments 21. The outer edge of the segments 21 slides to contact the outer walls of the grooves 11, 13 during operation, while the segments 21 are at a slight distance from the teeth 12. The shaft 3 is only guided axially during operation by the flanks of the pistons.

In the present case, the preferred materials for an actuator according to the invention are aluminum for the housing 1 and the shaft 3, and plastic for the pistons 4 and 5. The seal

at the bearing sites can be attained by self lubricating plastics. Other materials or combinations of materials are equally conceivable, however. The bearing only receives a small amount of stress during operation since it is an actuator as used for actuating valves.

Patent Claims

1. Pneumatic actuator comprising a housing (1) which has a pneumatic cylinder (6), and comprising at least one piston (4, 5) that can move inside the cylinder (6) in the direction of the axis of the cylinder (6) and, together with the cylinder (6), delimits a working space (32, 33, 34), whereby the piston (4, 5) has teeth (20) which extend in the direction of the axis, and comprising a shaft (3) which can rotate in an axial direction (2) whose axial direction (2) is perpendicular to the axis, and which has teeth (12) that engages with the teeth (20) of the piston (4, 5), **characterized in that** the piston (4,5) fixes the shaft (3) in its axial direction (2) by means of positive engagement.

2. Actuator according to claim 1, **characterized in that** the shaft (3) has at least one peripheral groove (11, 13) that engages with a segment (21) of the piston (4,5) running in the axial direction.

3. Actuator according to one of the prior claims, **characterized in that** the shaft (3) has two bearing areas (10, 14) that form the areas where the shaft (3) has the greatest diameter.

4. Actuator according to one of the prior claims, **characterized in that** the shaft (3) is mounted directly in the housing (1) at two bearing sites (22).

5. Actuator according to one of the prior claims, **characterized in that** the bearing sites (10, 14) of the shaft of (3) essentially have the same diameter.

6. Actuator according to one of the prior claims, **characterized in that** the groove (11, 13) is a peripherally cut groove.

7. Actuator according to one of the prior claims, **characterized in that** each piston (4,5) has a total of two of the segments (21) neighboring the teeth (20).

8. Actuator according to one of the prior claims, **characterized in that** the pistons (4,5) are made of plastic.

9. Actuator according to one of the prior claims, **characterized in that** the working area (33) in the area of the bearing sites (11, 14) of the shaft (3) is sealed from the exterior by means of sealing rings that are placed in a groove of the shaft (3).

10. Method to mount an actuator according to one of the prior claims, **characterized in that** first the shaft (3) is inserted in the bearing sites (22), and then the piston(s) (4,5) engage with the shaft (3).

11. Method according to claims 10, **characterized in that** the shaft (3) is held in the bearing sites (22) without additional fasteners.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

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(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **ALFA LAVAL FLOW GMBH** [DE/DE]; Heerdter Lohweg 63-71, D-40549 Düsseldorf (DE).

(72) Erfinder; und
(75) Erfinder/Anmelder *(nur für US)*: **HESSLING, Peter** [DE/DE]; Katzemer Strasse 27, D-41812 Erkelenz (DE).

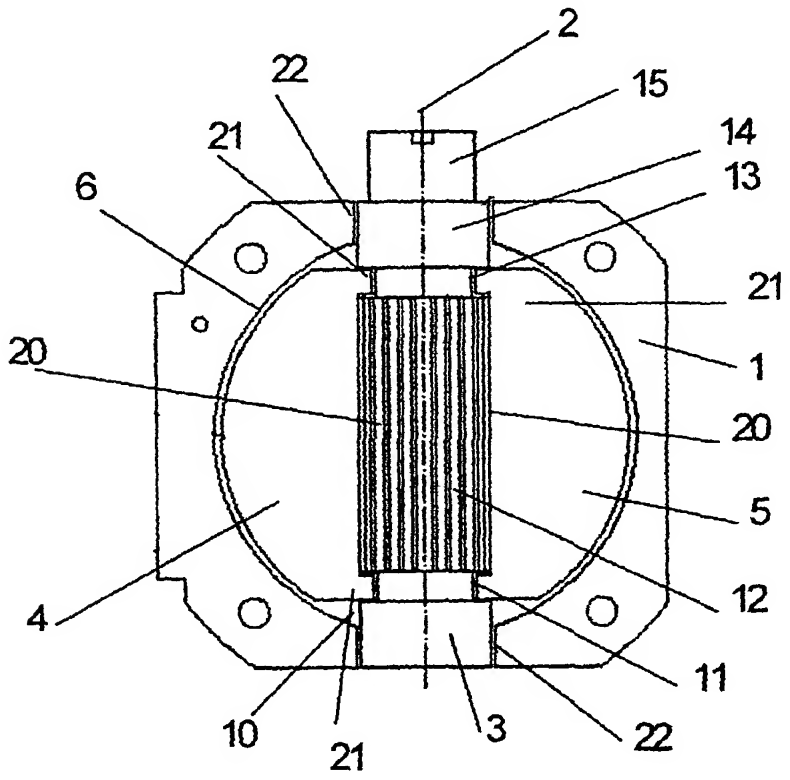
(74) Anwalt: **LENZING, Andreas**; Münsterstrasse 248, D-40470 Düsseldorf (DE).

(81) Bestimmungsstaaten *(national)*: AU, IN, US.

[Fortsetzung auf der nächsten Seite]

(54) Title: SHAFT MOUNTING

(54) Bezeichnung: WELLENLAGERUNG



(57) Abstract: The invention relates to a pneumatic actuator comprising a housing (1), which has a pneumatic cylinder (6), and comprising at least one piston (4, 5). Said piston can move inside the cylinder (6) in the direction of the axis of the cylinder (6) and, together with the cylinder (6), delimits a working space (32, 33, 34). The piston (4, 5) has a gearing (20) which extends in a direction of the axis. The inventive pneumatic actuator also comprises a shaft (3) which can rotate around an axial direction (2), whose axial direction (2) is vertical in relation to the axis, and which has a gearing (12) that engages with the gearing (20) of the piston (4, 5). A less complex structure is obtained by virtue of the fact that the piston (4, 5) fixes the shaft (3) with positive engagement in the axial direction thereof (2).

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WO 01/14751 A1

WO 01/14751

PCT/EP00/08191

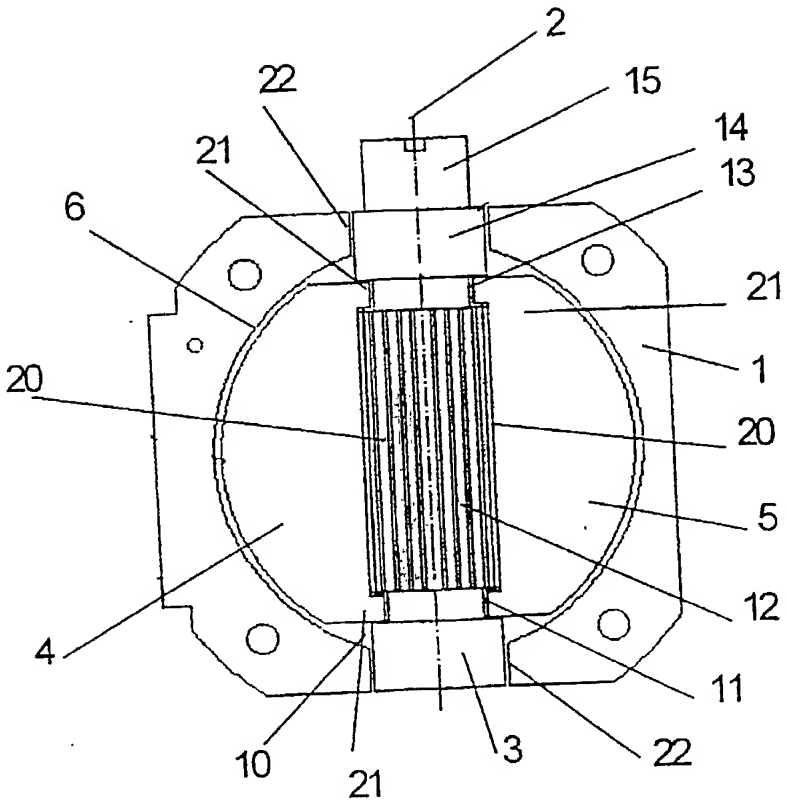

Fig. 1

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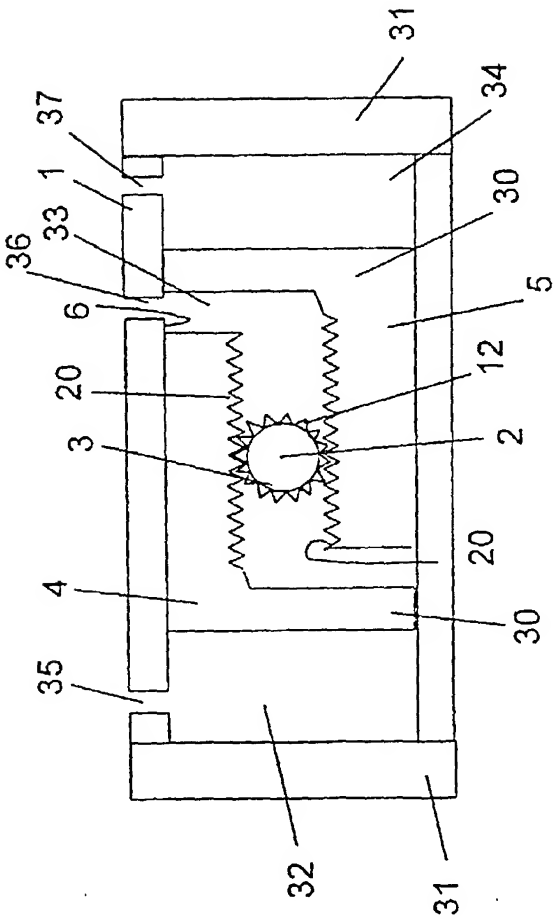

Fig. 2

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	LEN-021022
First Named Inventor	Hessling
COMPLETE IF KNOWN	
Application Number	10/069,830
Filing Date	2/26/02
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SHAFT MOUNTING

(Title of the Invention)

the specification of which

☒ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 08/22/2000 as United States Application Number or PCT International Application Number PCT/EP00/08191 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	Certified Copy Attached? NO
19940644.8	Germany	8/26/1999	☐	☐	☒
PCT/EP00/08191	PCT	8/22/2000	☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

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DECLARATION — Utility or Design Patent Application

Direct all correspondence to: [X] Customer Number or Bar Code Label		OR [ ] Correspondence address below	
Name Jody L. Factor			
Address 1327 W. Washington Blvd., Suite 5G/H			
City Chicago	State IL	ZIP 60607	
Country USA	Telephone (312) 226-1818	Fax (312) 226-1919	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR: [ ] A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any]) Peter	Family Name or Surname Hessling		
Inventor's Signature P. Hess			Date 2.7.02.2002
Residence: City Erkelenz	State	Country Germany	Citizenship Germany
Mailing Address Katzerner Strasse 27			
City Erkelenz	State	ZIP D-41812	Country Germany

NAME OF SECOND INVENTOR: [ ] A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])	Family Name or Surname		
Inventor's Signature			Date
Residence: City	State	Country	Citizenship
Mailing Address			
City	State	ZIP	Country

[ ] Additional inventors are being named on the ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.